

LV.—Notes on the Faculty of Changing Colour in Reptiles.
By P. DE GRIJS*.

UNDER the heading "Briefliche Mitteilungen" in no. 9 of the last annual volume of 'Der Zoologische Garten' there appears a communication from Dr. A. Hanau on the coloration of the interstitial integument in *Tropidonotus ordinatus*, var. *sirtalis*. On reading the lines in question the thought involuntarily occurred to me how little, after all, any observations are capable of enlightening us as to the causes and efficacy of so many phenomena in the animal kingdom. As the gentleman referred to will undoubtedly have remarked, the question in the case of *T. ordinatus* and all other species which have a brightly coloured or marked interstitial integument is not of a power of changing colour, but of fixed colours, which when the body of the snake is not distended remain invisible owing to the closely approximated scales. All the species of snakes that I have hitherto observed possessed no trace of a power of changing colour, such as is found in many other reptiles and batrachians; I have never read that snakes possessing the power of changing colour have been observed, and I think that I shall not be wrong in absolutely denying to this order the faculty of sudden alteration of hue. Now what can be the reason that no single snake possesses the power of changing colour? To these animals, as protection against enemies or for the purpose of stealing upon their prey, a change of colour would in many cases be of just as great advantage as to many Lacertilia. Leaving out of the question the poisonous snakes, which are sufficiently protected from attacks by their bite, there still remains the great multitude of non-poisonous species, which have many enemies. It is true that many non-poisonous snakes possess great activity and swiftness; but the same qualities are likewise shared by a large portion of the Lacertilia which are able to change colour. I content myself with having raised the question; it would be interesting to bring about an exchange of opinions on the subject. The fact that crocodiles and Chelonians are devoid of the power of changing colour cannot reasonably create astonishment; nature has furnished these creatures with sufficient equipment for defence. But that among the snakes there are no species at all with a more or less developed power of changing colour is a fact that must attract our attention. We

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might well ask why it is that, in the struggle for existence, no species of snake has been produced with a skin similar in constitution to that of the Lacertilians which change their hue. It may be that the constitution of the integumentary coverings and of the skin itself is of such a kind that a different arrangement of the pigment-cells cannot take place. In order to decide the question it would be necessary in the first place to determine what are the qualities in respect of which the skin of reptiles which change their colour differs fundamentally as regards anatomy from that of those not endowed with this faculty. After that we might perhaps hope to acquire information as to the reason why a large number of lizards and all snakes are without the power of changing colour.

In the Lacertilia the external constitution and covering of the skin does not allow us to infer with certainty the possession of the power of changing colour. It is true that, generally speaking, it may be stated that lizards with a porous integumentary covering (those that become wet if placed in water) frequently possess the power of changing colour, and that those with non-porous scales (from these water drips off as from a greasy object) have none; but there are exceptions to both categories. Most of the Lacertilia that change their colour are distinguished by having small non-imbriated scales; but here also there are exceptions, and, on the contrary, many fine-scaled Lacertilia cannot change colour. It is consequently impossible to set up any definite rules, and to undertake a description of the coloration of Lacertilia based upon spirit-specimens has therefore only a conditional value. It is true that the Lacertilians which change colour generally assume the same coloration in death, so that it is possible to determine spirit-specimens. An attempt, however, to determine species of *Anolis*, for example, from descriptions of colour alone would scarcely lead to a definite conclusion as to the classification of a species.

The power of changing colour in Lacertilia differs greatly—on the one hand as regards intensity and frequency, on the other in respect of the purposes which it serves.

Whether, after all, in the case of *Lacerta agilis*, *viridis*, and *muralis* we would regard as the faculty of changing colour the regular alteration of hue in spring or at the pairing-season of the species inhabiting temperate zones is a question that may remain undecided; it is true that it does not depend upon the will of the creatures themselves, but neither can it be compared with the alteration of colour in mammals and birds. At any rate I am of opinion that here

also there ensues a movement of the pigment-cells, which certainly is quite slow, but nevertheless analogous to that which takes place in the creatures which are capable of changing colour quickly. This view is supported by the fact that also in the case of the Lacertilia which change their colour in the course of quite a short space of time the will is not always active, but, on the contrary, external influences compel the animal to change its colour. A chamæleon that has been exposed for a time to great heat always becomes bright yellow.

The intensity of the colour-change differs extremely in the different species. In the first instance two groups can be established:—

I. Ground-colour and marking alter equally in tone, but the marking does not disappear.

II. Ground-colour and marking each alter in tone independently of the other; spots may entirely disappear.

To the former group belongs, for instance, *Eumeces Schneideri*. Under the influence of heat this species always appears quite bright greyish yellow, with bright yellowish-red spots. In an unheated cage the animal assumes a dark greyish-brown colour, and the spots appear brick-red. Of the lizards that I have kept I also assign to this group *Tarentola annularis*, which varies from blackish brown to bright sand-colour, with constant marking; *Uromastix*, which likewise appears lighter under the influence of heat; *Sceloporus undulatus*, the upper surface of which assumes a considerably brighter tone under the influence of the sun's rays; *Crotaphytus collaris*, a species which, when the temperature is low, appears dusky grey, while in heat the head becomes almost white, the body bluish grey, the feet appear shining bluish green, and the tail becomes bluish white, but all markings composed of spots remain constant; besides these there are *Phrynosoma cornutum* and *Amphibolurus barbatus*, both of which become brighter under the influence of heat, various species of ground Agamæ (*Agama mossambica* and *A. stellio*), as also *Cachryx defensor*, of which the body-colour passes from blackish grey to light blue, while the marking of spots remains unaltered.

To the second group belong, among others, *Anolis*, *Agama sanguinolenta* and *A. inermis*, *Phrynocephalus*, *Iguana*, *Calotes*, and *Chamæleon*. *Chamæleon* really forms a group by itself, since its power of changing colour materially exceeds that of all other species. In the species mentioned there consequently takes place a double change of colour in a more or less pronounced degree, in so far as ground-colour and spots

can each undergo a change of hue independently of the other. Taking the body as a whole, the number of different colorations which *Chameleon*, in particular, is able to assume becomes in this way very large. Moreover, at least in *Iguana*, *Calotes*, and *Chameleon vulgaris* (not in all varieties), the spots may entirely disappear, which is never the case in the species of the first group. It is, however, important to draw attention to the fact that, so far as my experience extends, no reptile that changes colour possesses the faculty of allowing alterations to take place in the outlines of the spots. Since the changes of tint recur with a certain regularity, it is after continued observation very easy to determine that ground-colour and spots always show precisely the same limitations so long as the animals do not appear of one colour. If we have once determined these limitations we shall find that no other pattern is ever produced under all gradations of tint; the spots always occur in precisely the same part of the body and have the same size and outline. Besides the faculty of changing its ground-colour and the colour of its spots independently of each other, *Chameleon* also possesses the power of producing another kind of marking. This marking consists in the entire body of the animal appearing as if strewn with numerous roundish black specks. The broad circle of the eyelid is then seen to be coloured in radii. This coloration only occurs when the animal is alarmed, and here also the number and arrangement of the spots are, as I have convinced myself, always the same.

It would lead us too far to give an enumeration of all possible changes of colour in the different species. Observation shows, however, that they recur with a certain regularity, and consequently must also have a definite object.

So far as it is possible to recognize this object, several divisions can again be set up, according to which the power of changing colour can be classified.

In the sense of the Darwinian theory, the power of changing colour may have arisen, or, let us say, have been developed:—

- I. For the purpose of protection against enemies.
- II. As a means of absorbing or warding off heat.
- III. Through sexual selection.

While in the case of some of the reptiles which change colour only one of the objects named is to be recognized, in others the change of hue fulfils two or even all of the purposes referred to.

It is to be regarded as protective coloration when *Agamæ* and *Geckos* assume the tint of the ground or bark so precisely as scarcely to be distinguished from the surface on

which they rest. The change of colour of the species of *Anolis* undoubtedly serves these animals in the first place for protection. That the change of colour in *Anolis* is partly spontaneous I was able to determine with certainty from specimens that I kept in captivity; for so long as I kept various examples of *A. principalis* in a vivarium destitute of plants it was only rarely and only under the influence of sunshine that the animals assumed the splendid green colour. Since, however, I have allowed the lizards to run about freely in a glazed verandah full of plants they are almost continually green, and this even when the sky is overcast. The change of colour in the chamæleon also serves the almost helpless animal preeminently for protection, for, as a Spanish proverb has it, "a chamæleon seen is a chamæleon lost"! It is an interesting fact that the power of changing colour in *Chamæleon vulgaris* has apparently adapted itself to the localities whence the specimens are obtained. Examples from places poor in vegetation are unable to produce the beautiful blue-green tints which are assumed by those coming from districts in which plants abound. Some years ago I received some extremely vividly coloured specimens of this kind which I was at first inclined to regard as belonging to a distinct species. I was not told where they had been found, and no such specimens have since come under my notice.

The coloration of *Iguana tuberculata* is also protective. It is true that in this species it is only variations from light and dark green that are possible; markings consisting of spots may either appear or disappear. The change of colour in *Iguana* seems to be more pronounced in young than in old animals; yet I have not sufficient experience as to this, since it was only quite a young individual that I was able to observe more closely.

That some species spontaneously utilize their power of changing colour in order to absorb or to ward off heat is perhaps of more subordinate importance. It is probably a matter of general knowledge that in cool weather *Chamæleon vulgaris* becomes almost black on the side on which the sun's rays fall. If the same species be exposed to great heat it becomes bright yellow. A specimen of *Amphibolurus barbatus* that I have been keeping for a long time turns a perfectly dark colour in the morning, when the first rays of the sun fall into its cage; at midday it is pale grey, and with continuous sunshine the head is almost white. Most of the Agamidæ and Iguanidæ, which inhabit the deserts and steppes, become paler under great heat.

Of much greater importance, on the other hand, is the

change of colour that takes place in many lizards in the male sex for the purpose of exercising an attraction over the females at the pairing-season. The occurrence in the Lacertilia of a power of changing colour in this direction is already in itself a proof of the higher development of these animals as compared with the snakes. Among the Ophidia we find little divergence in the colour of the sexes and in the shape of the body, indeed, apart from the length of the tail, scarcely any difference at all. In the Lacertilia, on the contrary, the difference between the sexes is frequently very strongly marked; I need only allude to the throat-sacs and crests.

Well-known examples of the power of changing colour which have probably arisen through sexual selection are afforded by *Agama inermis* and *Sceloporus undulatus*. In respect of the Darwinian theory these species are so much the more interesting in that in them, simultaneously with the colour-changing faculty, quite peculiar habitual movements have been developed. In order to remain invisible to the eyes of their enemies—probably in the majority of cases birds—when looked at from above it was necessary that the change of colour should be confined to the throat and sides of the belly. Lest, however, the beauty of their wooers should escape the glances of the females, the former had to adopt their peculiar nodding and bobbing up and down movements, in order to render their chief adornment visible. The splendid blue coloration of the throat and sides of the belly in *Agama inermis* and *Sceloporus undulatus* is, moreover, not so much spontaneous as dependent on the temperature. In the case of *Agama* the blue colour disappears entirely in cool weather or persists upon the throat only in the form of a blackish marbling; in *Sceloporus* during cold the blue passes into black, but generally allows a blue metallic sheen to be detected. I am not aware whether *Chameleon* arrays itself in especially vivid colours at the breeding-season. I am inclined to think, however, that the species employs its peculiarly well-developed power of changing colour also as a means of attracting the female sex; and I do so because the extremely quarrelsome males at once assume vivid colours on catching sight of one another.

Our knowledge of colour-change in Lacertilia is probably exceedingly small in comparison with that which has still to be discovered. Most of the species which change colour are small and delicate animals that never reach Europe alive at all. That the large powerful species are less in need of a protection derived from colour is evident; they will therefore, in the majority of cases, have fixed colours. Anyone who

looks through a collection of smaller lizards preserved in alcohol will scarcely gain an idea of the splendour of colour that many of the faded carcasses may exhibit in life. At any rate, for the purpose of an exhaustive study of Lacertilia the observation of living material can be much less easily dispensed with than in the case of the Ophidia. It would therefore be desirable that such zoological gardens as seek to advance science should direct their attention more than hitherto to the importation of the first-mentioned animals. With the commercial relations that Germany possesses a successful result should not be difficult of attainment, and should scarcely entail any considerable monetary sacrifice.

LVI.—*The Poisonous Snakes of British Guiana.*

By J. J. QUELCH, B.Sc. (Lond.), C.M.Z.S.*

IF an ordinarily well-informed person be questioned as to the abundance or paucity of poisonous snakes in the Colony, no doubt the answer would deal rather with swarms than with a few, with the implication not only of numbers of any one particular kind, but also of many different species. And yet, as a fact, there are only about eight well-marked different species, of which two pit-vipers only are of such common occurrence as to present some element of dread to general travellers. In the open savannahs or cleared lands and on the sparsely clumped sandy wastes the rattlesnake is likely to be encountered, while in the forest itself or adjoining lands the labarria (known variously in different districts as Jararaca or Fer-de-lance) takes its place.

Of the remaining six species two are pit-vipers and four coral-snakes; but while, from their general size and character, the pit-vipers and one of the coral-snakes are certainly to be feared if met with, the other three seem to be usually altogether inoffensive creatures, and, in fact, much less ready or more disinclined to bite if irritated or handled than the generality of the common harmless snakes.

In using the term poisonous snakes it must be understood to refer only to those special forms which, from the perfection of the poison-apparatus, are able to cause serious injury or death to man and other large mammals. Such are the vipers and those members of the Colubrine division which bear

* From 'Timehri: the Journal of the Royal Agricultural and Commercial Society of British Guiana,' vol. xii. part i., new ser., 1898, pp. 26-36.